A sensor arrangement

The present invention relates to a sensor arrangement, in particular as part of a reflection light barrier, comprising a carrier on which a photodiode, a first light emitting diode for the transmission of a measuring light beam, in particular a pulsed measuring light beam, and a second light emitting diode for the transmission of a reference light beam, in particular a reference light beam pulsed offset in time with respect to the measuring light beam, and a light transmitting housing enclosing the photodiode and the two light emitting diodes are arranged.

In a known sensor arrangement for reflection light barriers of this type, two LED chips and one photodiode chip are arranged on a circuit board. The LED chip provided for the transmission of the reference light beam directly irradiates the adjacent photodiode, with a large part of the light being radiated into the side surface of the photodiode due to the position of both chips on one plane. The other LED chip provided for the transmission of the useful light beam, in contrast, only radiates upwardly, since it is located in a separate part of the housing. If a reflecting object is located in its beam cone, the reflected light is incident on the photodiode from above.

On the irradiation of a photodiode with a light pulse, the photo current resulting from the irradiation of the photodiode follows the light pulse with a specific delay which is quantified by the rise time and the decay time of

the photo current. These times generally depend both on the electrical parameters of the photodiode, above all on its capacity, and on its external electrical wiring, substantially on the load resistance. There is furthermore, however, a clear dependence on the direction of the optical radiation. If the light is not incident onto the semiconductor chip primarily from above, but penetrates into the chip through the side surfaces, a considerable increase in the rise time and decay time occurs. The photodiode therefore becomes slower. The reason for this is probably the following: with lateral radiation, a large portion of the production of free charge carrier pairs caused by absorption of the light takes place in the substrate of the chip. Before these charge carrier pairs can contribute to an electrical current, they must first diffuse into the region of the p-n junction, which results in a delay.

In the specific application, both LED chips are operated in an alternately pulsed manner, whereby the sensitivity to ambient light of the reflection light barrier can be eliminated with the help of an electronic circuit. The different time behavior for the light radiation onto the photodiode from the side or from above causes large problems for the evaluation electronics in this process.

These problems are solved by a sensor arrangement having the features of claim 1. The solution accordingly consists of a sensor arrangement, in particular as part of a reflection light barrier, comprising a carrier on which a photodiode, a first light emitting diode for the transmission of a measuring light beam, in particular a pulsed measuring light beam, and a second light emitting diode for the transmission of a reference light beam, in particular a reference light beam pulsed offset in time with respect to

the measuring light beam, and a light transmitting housing enclosing the photodiode and the two light emitting diodes are arranged, which is characterized in that the second light emitting diode is arranged on the carrier such that the reference light transmitted by it is essentially not incident on the photodiode from the side.

The reference light transmitted by the second light emitting diode therefore substantially acts on the photodiode only along an indirect reference light path. The reference light transmitted by the second light emitting diode is in particular substantially incident onto the photodiode due to the reflection at the wall of the housing. This reflection is in particular based on a total reflection.

In accordance with a particularly preferred embodiment of the invention, the photodiode is arranged on a first plane of the carrier and the second light emitting diode serving for the radiation of the reference light is arranged on a second plane. This is particularly simple in manufacture and is in particular then already alone sufficient to largely avoid a lateral radiation of reference light into the photodiode, when the two planes are offset with respect to one another at least by the height of the photodiode or of the second light emitting diode. The radiation of reference light onto the photodiode can thereby only take place via reflections at the walls of the housing such that the radiation onto the photodiode substantially takes place from above.

The second light emitting diode is preferably arranged on a higher plane than the photodiode. Generally, however, the arrangement could also be reversed.

In particular a circuit board is provided as the carrier, with the circuit board preferably being formed in the manner of a sandwich plane of at least two layers. This is also again simple and cost favorable in manufacture. The manufacture of the layers in particular takes place by lamination.

It is moreover particularly preferred for the carrier to consist of a material impermeable to light. Other irritating radiations onto the photodiode can thus also be prevented.

The housing is preferably formed by an encapsulant of light-permeable material such as epoxy resin. This material has been found to be particularly suitable to ensure both a transmission of the measuring light to an object to be detected and a reflection of the reference light at the housing.

The housing can preferably be made chamfered in the region of the second light emitting diode for the improvement of the reflection at the walls of the housing and for the prevention of a detection of an object by the reference light. On the other hand, a lens is preferably provided in front of the first light emitting diode for the focusing of the measured light in the direction of a possible object to be detected.

An embodiment of the invention is represented in the drawing and will be described in the following. There is shown as the only Figure in a schematic representation

Fig. 1 a cross-section through a sensor arrangement in accordance with the invention.

The sensor arrangement shown includes a circuit board 1 as a carrier comprising a first layer 1a and a second layer 1b which is laminated on it, but only covers part of the first layer 1a. Two planes 2a and 2b are thereby formed for the carrier.

A photodiode 3 and a first light emitting diode 4 are arranged next to one another on the first plane 2a, while a second light emitting diode 5 is provided on the second plane 2b. The photodiode 3 is located directly next to the second layer 1b of the carrier 1 and the height of the second layer 1b is selected to be somewhat larger than the height of the photodiode 3. The first light emitting diode 4 is located spaced apart on the side of the photodiode 3 remote from the second light emitting diode 5.

An encapsulant made from an epoxy resin is applied to the circuit board 1 and forms a housing 6 which receives the photodiode 3 and the two light emitting diodes 4 and 5. The first light emitting diode 4 is located in this process in a separate region of the housing 6 which is separated by a crosstalk barrier (not shown here) from the photodiode 3 and from the second light emitting diode 5 such that light transmitted by the first light emitting diode 4 cannot be incident on the photodiode 3 from the side. A lens, likewise not shown here, is moreover arranged in front of the first light emitting diode 4. On the other side, the housing 6 is formed with a chamfered surface 7, a so-called facet, in the region of the second light emitting diode 5.

The first light emitting diode 4 serves for the production of measuring light which exits the housing 6 and is reflected by an object 8 located in front of the housing 6. The measuring light transmitted by the first light emitting diode 4 thereby arrives at the upper side 3a of the photodiode 3, in accordance with the arrows I and II, and produces an electrical signal in it. The light emitting diode 4 is operated in a clocked manner in this process.

The second light emitting diode 5 is activated offset in time with respect to it. It transmits a reference light beam which is reflected at the walls of the housing 6 such that it is reflected onto the upper side 3a of the photodiode 3 in accordance with the arrows III and IV. The ambient light can be calculated out by subtraction of the two signals. In addition, the reference light signal produced by the second light emitting diode 5 can be used for a regulation.

As can be seen, the arrangement of the second light emitting diode 5 on the second plane 2b formed by the second layer 1b of the carrier board 1 prevents a lateral radiation of reference light into the photodiode 3. The reference light therefore radiates, like the reflected measuring light, onto the photodiode 3 substantially only from above. The time behavior of the reference light signal thus corresponds to that of the measured light signal in the photodiode 3, whereby the problems initially described are avoided. Low rise times and decay times of the photodiode 3 can in particular also be achieved with respect to the reference light in this manner.

Other misguided light can also largely be excluded by the forming of the two layers 1a and 1b of the carrier board 1 from a material impermeable to light.